PATENT ABSTRACTS OF JAPAN

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(54) METALLIC PLATE AND CONTAINER FOR INDUCTION HEATING APPARATUS AND MANUFACTURE THEREOF

(57)Abstract:

PROBLEM TO BE SOLVED: To prevent deterioration in heat generating property, formability, corrosion resistance, etc., by forming a conductive layer having a specified rupture elongation value in part of external surface of aluminum or aluminum alloy material.

SOLUTION: Part of external surface of a heating metal plate is formed with an electric conductive layer serving as a heat generating layer. The conductive layer is specified to have an elongation value of 1% to 30% at rupture. On the other hand, the aluminum plate used is a soft material and exhibits elongation of 30% to 50% at rupture. Therefore, if a conductive material combined with aluminum has an elongation of less than 1%, the conductive material develops defects such as cracks. As a result, forming process is difficult, and the material has a very small impact strength. The cracks in the conductive layer may lead to gap corrosion occurring on boundary surfaces of different metals. Furthermore, although the conductive layer has to be placed in alternating magnetic field to induce an eddy current in the conductive layer, heat generating property is remarkably reduced as the eddy current is interrupted by the cracks.

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CLAIMS

[Claim(s)]
[Claim 1]An electromagnetic heating dexterous metal plate characterized by a thing of an outside surface of aluminum or an aluminum alloy for which elongation after fracture formed 30% or less of conductive layer 1% or more by electroplating in part at least.
[Claim 2]The metal plate for electromagnetic heating according to claim 1 whose elongation after fracture of a conductive layer is not less than 3%.
[Claim 3]The metal plate for induction heaters according to claim 1 to 2 which forms an interlayer who consists of zinc or a zinc alloy between aluminum or an aluminum alloy, and a conductive layer.
[Claim 4]A container for induction heaters characterized by a thing of an outside surface of a container of aluminum or an aluminum alloy for which elongation after fracture formed 30% or less of conductive layer 1% or more by electroplating in part at least.
[Claim 5]The container for induction heaters according to claim 4 which forms an interlayer who consists of zinc or a zinc alloy between aluminum or an aluminum alloy, and a conductive layer.
[Claim 6]A manufacturing method of an electromagnetic heating dexterous metal plate, wherein elongation after fracture which an outside surface of aluminum or an aluminum alloy plate forms in part at least forms 1% or more 30% or less of conductive layer into an electrolytic bath with electroplating which performs non oxidizing gas bubbling.
[Claim 7]A manufacturing method of a container for induction heaters, wherein elongation after fracture which an outside surface of aluminum or an aluminum alloy container forms in part at least forms 1% or more 30% or less of conductive layer into an electrolytic bath with electroplating which performs non oxidizing gas bubbling.
[Claim 8]Elongation after fracture to at least a part of outside surface of aluminum or an aluminum alloy plate as 30% or less of a conductive layer 1% or more, A manufacturing method of an electromagnetic heating dexterous metal plate covering not less than 40 micrometers of ferronickel alloy films which carried out electrocrystallization while iron trivalent

ion carried out non oxidizing gas bubbling from 4% or less of electrolytic bath of total-iron ion content.

[Claim 9]Elongation after fracture to at least a part of outside surface of aluminum or an aluminum alloy container as 30% or less of a conductive layer 1% or more, A manufacturing method of a container for induction heaters covering not less than 40 micrometers of ferronickel alloy films which carried out electrocrystallization while iron trivalent ion carried out non oxidizing gas bubbling from 4% or less of electrolytic bath of total-iron ion content.

[Claim 10]an induction heater of claim 6 or claim 8 -- public funds -- electromagnetic heating which molded a group board into a container so that said conductive layer might become outside -- public funds -- a manufacturing method of a group container.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]The invention in this application relates to the vessel which is applied to the metal plate for electromagnetic heating and the container for electromagnetic heating, and its manufacturing method, especially is used for electromagnetic heating type cookware, and the metal plate used for it.
[0002]
[Description of the Prior Art]Conventionally, the vessel used for electromagnetic heating type cookware, for example, a rice cooker inner kettle, uses as a substrate the compound plate of magnetic metal boards, such as iron, stainless steel, etc. which take charge of generation of heat, and aluminum and the aluminum alloy plate which take charge of ****, and by making the latter board into the inside, deep drawing etc. carry out press-forming processing, and it manufactures this. moreover -- cooking rice sticks to an inside inner surface -- etc. -- generally a fluoro-resin is coated for prevention. As for this substrate slack compound plate, the material by the method of carrying out a clad (composite-izing) was used by roll pressure Nobu JP,54-3468,B and given in JP,54-9985,B in a magnetic metal board, aluminum, or an aluminum alloy, for example. The contents which carry out covering formation of the magnetic metal layer in thermal spraying are indicated by the external bottom of the container made from a light metal given in JP,59-155035,U. Since heat transfer of the generation of heat by a magnetic layer being uniformly carried out to a container since a light metal's is excellent in thermal conductivity, and thermal spraying are coating which is low cost, it is indicated that it is low cost as a whole.
[0003]
[Problem(s) to be Solved by the Invention]Said compound plate is manufactured by the clad method by roll pressure Nobu, and is suitable for mass production. However, since it was made from roll pressure Nobu, in order to compress aluminum or an aluminum alloy and to join, the variation in board thickness was large, the crack arose in the process in which press

forming of the clad plate is carried out for this reason, or wrinkles arose in many cases, and processing had a big problem. The compound plate of magnetic metal boards which are the materials which take charge of generation of heat, such as iron or stainless steel, and aluminum and the aluminum alloy plate which take charge of **** needs to double and have a function for both sides to be rich in spread nature, and be equal to strip processing or a fabricating operation, and material selection has many limiting factors.

[0004]By the clad method by roll pressure Nobu importance is attached to recycling of material for effective use of an industrial resource, after producing a magnetic metal board, aluminum, or the compound plate of an aluminum alloy plate, it pierces in predetermined shape and it is processed in recent years. under the present circumstances, it generates so much -- it strikes, and of course, a draught is a compound plate, and the recycling instead of a simple metal plate has difficulty like aluminum or an aluminum alloy plate, and it leads to a high cost. Manufacture of the compound plate which formed the magnetic metal board in the predetermined place of aluminum or an aluminum alloy plate beforehand at the required portion is also difficult. When forming a magnetic metal layer, the thermally sprayed film itself does not have a metal texture originally, but since plastic deformation is difficult, it is necessary to cover a magnetic metal layer with a spraying process after a molding process. That is, it is technically difficult to carry out a molding process after magnetic metal layer generation, and is not indicated by said JP,59-155035,U, either. Although the method of forming the magnetic metal layer after a molding process was also in the container, there was a problem that it was not enough in respect of corrosion resistance, shock resistance, and processability.

[0005]then, the electromagnetic heating in which this invention has the following features -- public funds -- a group container, a board used for it, and a manufacturing method for the same are offered a technical problem.

(a) Have a suitable heat generation characteristic.

(b) A fabricating operation be easy.

(c) It is thing (d) low cost with many selection ranges of a magnetic metal material.

(e) Excel in anticorrosion and shock resistance.

[0006]

[Means for Solving the Problem]In this invention, a magnetic metal layer (only henceforth a "conductive layer") by which elongation after fracture was formed in an outside surface of aluminum which is a conductive-heat layer, or an aluminum alloy plate of 30% or less of electroplating 1% or more is provided. Making it elongation after fracture of a conductive layer have 30% or less of characteristic 1% or more, after molding into a container preferably, for that purpose, elongation after fracture of a conductive layer before molding needs to have 30% or less of characteristic not less than 3%. Elongation after fracture of a conductive layer which there is almost no influence in aluminum, aluminum alloy layer thickness, or elongation, and functions as an exothermic layer of induction heating is important for a crack in the case of a molding process, or the formation of wrinkles. Forming non-oxidizing gas bubbling with

electroplating enforced always or intermittently says this conductive layer from elongation of a conductive layer, or a point of thickness control and a manufacturing cost, and it is important for it. This non-oxidizing gas refers to inactive gas, such as nitrogen, argon, and helium, and mixed gas which does not contain an oxygen atom.

[0007]In this invention, elongation after fracture forms 30% or less of conductive layer in an outside surface of a container of aluminum or an aluminum alloy 1% or more. A container of aluminum used as a substrate of electroplating, or an aluminum alloy besides what was beforehand fabricated in a container with a casting etc. Press-forming processing and/. Or it is aluminum or aluminum alloy production type processed goods which performed and carried out cut processing of the punching processing, and a conductive layer may be formed in an outside surface of the molding process article.

[0008]Compared with frequency of alternating field which high frequency induction heating impresses, it is necessary to form thickness of this conductive layer still more thickly than the depth of a skin effect which becomes settled with material of a conductive layer. Although there is no maximum thickness theoretically, it does not need to be too thick from becoming processability and a high cost, and the less than twice of the depth of penetration are suitable.

[0009]In this application, it is also possible to carry out the molding process of the plate, and advanced adhesion is required of a conductive layer and a conductive-heat layer for a molding process. Therefore, it is preferred that adhesion forms an interlayer of aluminum or an aluminum alloy which is not expensive, and an outside surface who consists of zinc or a zinc alloy in part at least, and forms a conductive layer on it originally.

[0010]As an example of a conductive layer, a monolayer which comprises at least one of nickel or a nickel alloy, iron or an iron alloy, cobalt, or the cobalt alloys, or two or more layers are preferred. In order to raise a heat generation characteristic further, making these conductive layers distribute at least one element of P, C, or B **, and raising electrical resistance to them is also considered.

[0011]In a use as which corrosion resistance is required especially of a conductive layer, it is preferred to form in an outermost surface of a conductive layer a corrosion-resistant layer which comprises heat resistant resin, such as ceramics, metal or Teflon. Especially as this corrosion-resistant layer, when food sanitation hygine and corrosion resistance are taken into consideration, it is preferred for a conductive layer to be nickel, a nickel alloy, iron, or an iron alloy, and to give a chromium metal which is 0.2-micrometer or more a thickness of 1 micrometer or less at a method of that outside, and a coat in which a chromium oxidation thing has multilayer structure.

[0012]It is preferred to get burned inside and to cover aluminum or the aluminum alloy surface with a fluoro-resin for prevention in the case of use to cooking.

[0013]

[Embodiment of the Invention]Although the conductive layer which functions as an exothermic layer is formed in a part of the outside surface, the elongation after fracture of the conductive

layer specifies that it is [1% or more] 30% or less in the metal plate used for the metal vessel for electromagnetic heating of this invention, or it. When pasting two or more sort metal together and considering it as composite like this invention about the reason this elongation is required, the elongation of composite follows the rule of mixture in many cases. This rule of mixture is the arithmetical average which gave dignity at a cross-section area rate of the elongation of each material.

[0014]In this invention, the aluminum used shows 30 to 50% of elongation after fracture with soft wood. When the elongation of the electrical conducting material compounded with this aluminum does not exceed 1% (i.e., when composite-ized in material which does not almost have elongation), defects, such as a crack, are produced in an electrical conducting material, and stress concentrates on a crack. For this reason, it was found out the whole composite fractured by far small elongation rather than having been expected by the rule of mixture. For example, in the material with which about 0.8% of material and elongation after fracture compounded 30% of aluminum alloy with iron nickel alloy material in simple substance elongation after fracture, 0.8% of elongation after fracture was observed. Thus, when one side of the material compounded had only the elongation after fracture which is less than 1%, the elongation of composite did not follow the rule of mixture, even when each class fully stuck, but artificers found out that elongation after fracture was determined by the pace of expansion by which fixed is carried out with a small material of elongation.

[0015]In the central value which artificers investigated according to working shape and processing conditions also the time of a molding process although required material elongation differed, it became clear that it was extended a maximum of 50% in the case of a molding process. However, the elongation after fracture as a material does not need to be not less than 50%. In order that this reason may not have an end which serves as a reference point of a fracture since modification of a molding process is the plastic deformation under a constraint but compressive force may commit it to elongation and a perpendicular direction, elongation after fracture becomes quite large. Although the rate that this elongation becomes large is based on clearance with the metallic mold of a fabricating operation, working speed, the presser-foot power of a work material, etc., it is extended to 10 or more times in many cases.

[0016]Electroplating after molding the charge of a thermal conductive material which comprises aluminum, liquid metal forging, When a shock against which molding material is cratered in a harder thing when the elongation after fracture of a conductive layer is low even when a conductive layer is formed by the spraying process or the various gaseous phase forming-membranes methods, and not following the rule of mixture is got, a crack occurs on the surface with a crater. That is, 1% or more of elongation is required for the conductive layer which forms aluminum and composite like this invention because of molding processability and the shock resistance of a cast.

[0017]A crack of this conductive layer causes crevice corrosion generated in a dissimilar metal interface, and when corrosion advances, the adhesion of the whole enveloping layer surface is

lost. Although it is required to arrange a conductive layer in alternating field, and for a line of magnetic force to permeate the inside of a conductive layer, and to excite an eddy current, since an eddy current is disconnected by this crack, a heat generation characteristic falls greatly. As a result of taking use at home into consideration, on the concrete floor surface, this shock-proof evaluation had a cast after processing in height of 1 m so that the bottom might turn to the bottom, and was performed by making it fall by lifting a hand. As a result, by the sample with which elongation after fracture is not filled to 1%, even when a conductive layer was formed on the surface of a molding material, since a crack occurred on the surface, it became clear that 1% or more of elongation was required.

[0018]The crack of this conductive layer causes a fall of the heat generation characteristic by division of an eddy current, and crevice corrosion as mentioned above. Therefore, a conductive layer is formed with plate shape and a working distortion solvent wiping removal is needed about a strong processing part, i.e., a lateral portion, by the case where the epigenesis type processing is performed. When the elongation after fracture of a conductive layer will be 1% or less and shock resistance is lost for work hardening by strong processing, it is possible to recover this by prolonged heat-treatment. However, since the heat treatment can consider oxidation of having a long time and a conductive layer, it needs to heat-treat in inactive gas.

[0019]Preferably, it is that the elongation after fracture of a conductive layer has 1% or more after a molding process, then the working distortion solvent wiping removal after a fabricating operation becomes unnecessary. When a conductive layer is formed with plate shape in consideration of work hardening by a fabricating operation for that purpose, it is necessary to make elongation after fracture of a conductive layer into not less than 3%.

[0020]A conductive layer is a material which generates heat by the eddy current generated by the magnetic flux of high frequency, and in the heating method by high frequency, if a conductor is arranged in the alternating field oscillated on the frequency of about 20 kHz used, for example for consumer electronics, an eddy current will occur and it will generate heat with the Joule heat of this current. For this reason, for heating efficiently, sizes, such as material of a container and thickness of material, have restrictions.

[0021]This is because the influence of the skin effect produced when the high frequency current flows into conductors, such as metal, is remarkable. It is determined by the skin resistance in using frequency whether each material is suitable as load of an induction heating cooker. Although a conductive layer is not limited to a metal kind, it can be used by making specific resistance increase by alloying centering on nickel or iron etc., and enlarging skin resistance.

[0022]In this invention, elongation after fracture is important. Although elongation after fracture is a mechanical property resulting from material, it is greatly influenced by the process formed. Although it mainly requires forming with electroplating in consideration of cost in this invention, it is necessary to care about that elongation becomes large also especially in the case of electroplating. In obtaining the big coat of the elongation by electroplating generally said, there

is a fall of the remaining stress by the bottom of the minuteness making of the metal texture by the electrocrystallization in comparatively big current density, streamlining of the brightening agent which is an organic system additive agent, and the elevated temperature of electrocrystallization temperature.

[0023]By this invention, although it could not be overemphasized that these known knowledge was followed, by this invention, it was considered as the factor which enlarges elongation and found out that the dissolved oxygen in an electrolytic bath was important. When dissolved oxygen existed in the electrolytic bath, oxidation of the metal ion took place, and although it was little, generation of a metallic oxide and generation of the high stress hard anodic oxidation coatings by the electrocrystallization from the ion of a high ionic valence were checked.

[0024]Generally, stirring by air bubbling is carried out by plating for the surface smoothness of an electrocrystallization coat, or pit prevention. By this air bubbling, since the increase in a dissolved oxygen amount has big influence on the elongation of an electrocrystallization coat, by this invention, bubbling by the inside of electrocrystallization or non-oxidizing gases, such as always, for example, nitrogen gas etc., is carried out.

[0025]This effect is large especially when an electrolytic bath contains iron. As an example, by the electrocrystallization of the iron nickel alloy from the nickel bath containing iron ion, trivalent iron ion increases during electrolysis and it will be in the state of coexisting with divalent iron ion required for electrocrystallization, by the dissolved oxygen by air bubbling. Although the electrocrystallization from divalent iron ion produces an iron nickel alloy coat with big elongation, in the electrocrystallization from trivalent iron ion, intermetallic compound $nickel_3Fe$ occurs and, in addition to the effect by stress, elongation after fracture falls. In this case, it is remarkable to become the elongation after fracture which elongation falls notably and is less than 1%, when trivalent iron ion exceeds 4% of total-iron ion.

[0026]Since a crack is not generated in a coat when forming a conductive layer on the surface of a molding body, or when [although the importance of the elongation like a molding process is reduced,] a shock which produces an indentation is got, the manufacturing process which took elongation into consideration as mentioned above is required. Since the crevice corrosion from the interface which a dissimilar metal comrade's joining interface will expose and was exposed will advance if a crack occurs in a coat in the case of composite, the danger of exfoliation of the whole coat becomes large.

[0027]Although there is no upper limit in particular about the thickness of a conductive layer, when a high cost and thermal conductivity are bad construction material, it is not necessary to exceed the thickness of aluminum. However, the lower limit is important. It is necessary to form still more thickly, the depth, i.e., the depth of penetration, of a skin effect of an eddy current to generate, the thickness of the conductive layer which consumes effectively the alternate magnetic flux generated according to the high frequency current, and serves as a heating element for generating heat.

[0028]This depth of penetration is the thickness from which the eddy current near the surface of a conductive layer is set to 1/e, i.e., thickness required for magnetic flux density to decline about 63%, and if it converts into electric power, it will be about 90%. That is, when the thickness of a conductive layer is thinner than the depth of penetration, in order not to consume the impressed magnetic flux energy thoroughly, but the depth of penetration specified by construction material at the lowest is required for the thickness of a conductive layer and to consume the supplied magnetic flux about 100%, a thing thick a little is preferred.
[0029]Since it generates heat efficiently about the construction material of a conductive layer, using iron alloys, such as nickel, a nickel-chromium alloy and iron, a permalloy, and stainless steel, etc. is mentioned to one as a means to increase skin resistance, in the material which constitutes a conductive layer. In this application, a ferronickel alloy (10 to 30% of iron content) is good as most suitable material from a heat generation characteristic and an industrial viewpoint.
[0030]By adding a phosphoric acid compound during a bath in the case of electroplating or chemical plating, By adding boron compounds, such as carbon eutectoid plating, for example, nickel-C, Fe-C plating, and aminoborane, by adding phosphorus eutectoid plating, for example, nickel-P plating, Fe-P plating, and a carboxylic acid system compound, Although boron eutectoid plating, for example, nickel-B, and Fe-B plating are obtained, these can increase skin resistance, with most of magnetic properties and the mechanical characteristic of a metallic material which it originally has maintained, and are dramatically effective for this use.
[0031]Since the surface of aluminum or an aluminum alloy is covered in the layer which uses oxidation aluminum as the main ingredients, in order to form the coat of a conductive layer with sufficient adhesion on this, it is necessary to take out a metal new field. Although there is a technique by the electron or an ion bombardment within vacuum devices as the technique of taking out a new field, in the case of electroplating or chemical plating, it is suitable to use zincate processing as the technique of depositing the metal of another kind, dissolving an aluminum surface. When a zinc simple substance may be sufficient in the case of aluminum, but it is an aluminum alloy, this zincate processing uses the zinc alloy containing elements, such as iron, nickel, and cobalt, in order to increase adhesion effectively.
[0032]When a conductive layer is nickel, a nickel alloy, iron, or an iron alloy, covering with a protective covering outer sheath is preferred as metaled discoloration prevention, but since the pan is considered as a container for induction heating cookers for the use of this invention, it needs to be [protective covering outer sheath / this] usable also in a food-sanitation-hygine top. For this reason, the chromium metal and the coat in which a chromium oxidation thing has multilayer structure which are formed by electroplating from a thin sulfate bath are used as a protective covering outer sheath.
[0033]Using the electrolytic bath which contains chromium ions in sulfuric acid thin in the case of electroplating, although structure changes somewhat with plating conditions, the coat of the two-layer structure of having a layer of the chrome oxide hydrated on the chromium metal is

formed. Although a sulfuric acid root is contained as an impurity in a genuine leather film, corrosion resistance can be raised a little by making a little fluorine ions mix into an electrolytic bath. In order that a line of magnetic force may be absorbed and a line of magnetic force may reach a conductive layer enough about the thickness of a coat, it is preferred that it is 1 micrometer or less of coat thickness.

[0034]Even when the elongation after fracture of a conductive layer is less than the elongation at the time of a molding process, a molding process becomes possible by forming only in the part where the elongation at the time of processing does not exceed the elongation after fracture of a conductive layer by a molding process still more thickly than the depth of the skin effect in which the thickness of a conductive layer becomes settled with the material of a conductive layer compared with the frequency of an eddy current. Without impressing magnetic flux, although it is not necessary to cover at all the part which does not need a conductive layer, since compound elongation will become large by the rule of mixture with aluminum if a conductive layer is thin enough, or if aluminum is thick enough, the molding process of it becomes possible.

[0035]When not forming a conductive layer selectively on aluminum or zinc ground plating, the crevice corrosion of the above-mentioned metal interface poses a problem. Then, it is preferred to cover with the form where a conductive layer and the whole gap part surface are wrapped in, further. In this case, if electrical conductivity covers with good metal, in an eddy current, current will flow simplistically, and since resistance is small, it becomes a cause of the circuit damage by having exceeded the permissible current of the transmitter of high frequency not only for not contributing to generation of heat but for an excess current. Therefore, it is preferred that contribute also to generation of heat to some extent, and electrical resistance also covers about 1/3 copper nickel with this invention. Since a conductive metal functions as an electromagnetic shielding layer about thickness, if thick, it will decrease, by the time magnetic flux results in the conductive layer which contributes by generation of heat. For this reason, the thinner one is preferred. For example, in the case of nickel, if magnetic flux density makes the neighborhood of the surface 100% by a thickness of 10 micrometers, it will decrease to about 80%. Elongation is enough, and if it covers with material with low amplitude permeability, this extinction ratio can consider falling and needs the thickness design according to the amplitude permeability of material.

[0036]This invention shows the range and manufacturing process of a mechanical characteristic which are excellent in a metallic material and processability, and shock resistance so that it may have a suitable heat generation characteristic as a conductive layer as mentioned above. Although it is also possible to form conductive layer thickness with high precision with the plating technique, after processing aluminum or an aluminum alloy into desired shape, the fabricating operation is made easy by forming a conductive layer in a required portion. Since there are also few losses of material and a use process is also electroplating or nonelectrolytic plating, it can create by low cost. [0037]

[Example]The example of this invention is described below. Drawing 1 -5 and drawing 7 are the vertical mimetic diagrams for explaining this invention. In drawing 1, set 1 to aluminum and 2 is set to an iron nickel alloy coat and drawing 2, 5 sets a fluoro-resin and 4 to an aluminum alloy, set it to a zinc undercoat layer, and 3 sets 6 to a nickel cobalt alloy coat and drawing 3, As for an aluminum alloy and 9, 7 is [an iron nickel alloy coat and 11] nickel layers a zinc undercoat layer and 10 a fluoro-resin and 8, and drawing 4 is a sectional view of the container the molding process was performed [the container] for the board shown by drawing 3.
[0038]Drawing 5 is the article which processed to the aluminum base material of vessel shape, and, as for an aluminum alloy and 14, 12 in a figure is [an iron nickel alloy coat and 16] chromium metal chrome oxide bipolar membrane a zinc undercoat layer and 15 a fluoro-resin and 13. Drawing 6 is the shape of the specimen used when measuring elongation after fracture. Drawing 7 is the article for which the conductive layer was formed in the aluminum base material of the shape of a pan, and, as for a fluoro-resin and 18, a zinc undercoat layer and 20 are ferronickel alloy films an aluminum alloy and 19 17 and 21.
[0039][Example 1] -- as the aluminum 1 of drawing 1 -- construction material JIS -- it is pure aluminum 1050 system and the circle plate of size the thickness of 2.0 mm, and 425 mmphi was used. After processing this aluminum alloy sheet at 80 ** in 120 g/L of sodium hydroxide solution, in the ordinary-temperature-water solution of 20 g/L of oxalic acid, the substrate was used as the anode and processing which impresses the voltage of 5V for 60 seconds was performed. Then, 320 g/L of nickel sulfate 7 hydrates, 20 g/L of nickel chloride, The electrolytic bath which added hydroxylamine chloride $NH_2OH \cdot HCl$ 15 g/L is used as a stabilizing agent of 18 g/L of ferrous-sulfate 7 hydrates, 30 g/L of boric acid, and divalent iron, It processed by having carried out the nitrogen gas bubble for 100-ml/by 60 ** of bath temperature, and cathode-current-density 5 A/dm^2, and about 150-micrometer nickel-Fe25% coat 2 which is a conductive layer was formed in the aluminum alloy sheet side. The sample which carried out the air bubble instead of the nitrogen gas bubble was also prepared for comparison. The heat generation characteristic was investigated for the produced metal plate for induction heaters using product IH cooker KZPmade from Matsushita electrical and electric equipment1.
[0040]When roll pressure extension of SUS430 of 0.5-mm thickness and the aforementioned aluminum alloy sheet was used as comparison material, what comparison material depends on this example compared with that to which skin temperature amounts to 60 ** in 10 seconds amounted to 95 ** with heating for 10 seconds, and obtained the good result. When elongation after fracture was investigated with the JIS No. 5 specimen (drawing 6), composite showed 35% of elongation after fracture. It was 5% which processed this specimen at 80 ** in 120 g/L of sodium hydroxide solution, dissolved only aluminum, separated only the coat 2, and measured elongation after fracture. When the plating sample by the air bubble produced to comparison investigated elongation after fracture with the JIS No. 5 specimen, it showed 0.8% of elongation after fracture with composite. It has been divided and processed, when processing was tried in a depth of 100 mm, and pan shape 250 mm in inside diameter so that

a conductive layer might become outside with a hydraulic press about a covering plate. Comparison material produced the fracture by the container lateral portion called a body crack at the time of a molding process.

[0041]Shock-proof evaluation dropped a 1-kg iron ball, and observed the shocked part by viewing. The part to drop was made into the container lateral portion to which elongation after fracture became small most with work hardening by a molding process. As a result of what is depended on a nitrogen gas bubble observing the shocked part, defects, such as a crack, were not observed by the coat although the crater was observed. It was 1.5%, when only aluminum was dissolved, only the coat 2 was separated and elongation after fracture was measured about the sample of the part which got this shock.

[0042][Example 2] As the aluminum 4 of drawing 2, the circle plate of construction material JIS3004 system aluminum containing alloy MG-110 (product made from the Sumitomo light metal) (0.6 to 0.8% of Mg and 0.9 to 1.1% of Mn are included), size the thickness of 1.5 mm, and 425 mmphi was used. That with which the fluoro-resin 3 is covered was used for one side of a circle plate. This substrate was immersed in the 70 ** solution of 80 g/L of SZ etching agents made from KIZAI, Inc. for 60 seconds, and dissolution removal was carried out for the natural oxidation film on the surface of an aluminum containing alloy. Then, it was immersed in the room temperature solution of 700 ml/L of nitric acid for 30 seconds 68%, and the firm oxide which remains on the surface was dissolved. Next, it was immersed in the room temperature solution of product made from KIZAI, Inc. super zincate SZ2 for 60 seconds, and the substitution deposit of the zinc alloy 5 was carried out on the aluminum base material. Then, electroplating processing was performed under nitrogen gas bubbling for 100-ml/using the electrolytic bath of 135 g/L of nickel sulfate 7 hydrates, 15 g/L of potassium chloride, 115 g/L of cobalt sulfate 7 hydrates, and 30 g/L of boric acid by 60 ** of bath temperature, and cathode-current-density 2 A/dm^2. As a result, about 100-micrometer nickel-Co15% coat 6 which is a conductive layer was formed in the aluminum alloy sheet rear face. The heat generation characteristic was investigated for the created metal plate for induction heaters using product IH cooker KZPmade from Matsushita electrical and electric equipment1.

[0043]What is depended on this example amounted to 100 ** with heating for 10 seconds, and obtained the good result. When elongation after fracture was investigated with the JIS No. 5 specimen (drawing 6), composite showed 5% of elongation after fracture. The sample in which the adhesion of the conductive layer was reduced was prepared in order to investigate the elongation after fracture of only a conductive layer. Since the substrate of this example was not pure aluminium but alloy aluminum, it did not apply the solution process of aluminum of Example 1, but chose the method by exfoliation. Construction material JIS3004 system aluminum alloy MG-110 which are a substrate of this example were started in the shape of the JIS No. 5 specimen, and it was considered as the substrate for an examination. This substrate was immersed in the 70 ** solution of 80 g/L of SZ etching agents made from KIZAI, Inc. for 60 seconds, and dissolution removal of the oxidation natural film on the surface of an aluminum

alloy was carried out.

[0044]Then, it was immersed in the room temperature solution of nitric acid 700 ml/L for 30 seconds 68%, and the firm oxide which remains on the surface was dissolved like ****. Next, generation of a zinc alloy coat is not performed for the purpose of falling the adhesion of the plating coat on an aluminum surface, Electroplating processing was performed under nitrogen gas bubbling for 100-ml/using the electrolytic bath of 135 g/L of nickel sulfate 7 hydrates by 60 ** of bath temperature, and cathode-current-density 2A/dm^2. As a result, about 100-micrometer nickel-Co15% coat 6 which is a conductive layer was formed in aluminum alloy plate both sides. The end face part of the specimen was ground, only the conductive layer was torn off, and it was considered as the specimen. When the elongation after fracture of this specimen was investigated, 1.8% of elongation after fracture was shown.

[0045]It has been divided and processed, when ******** was tried in a depth of 146 mm, and rice cooking jar inner kettle shape 221 mm in inside diameter so that a conductive layer might become outside with a hydraulic press about this covering plate. In this fabricating operation, a maximum of 50% of elongation was checked by the flank part. In the rising portion from a bottom portion to a flank part, it was 5% of elongation. The place which carried out cooking rice using the jar rice cooker of marketing of mold goods. It checked that cooking rice was satisfactorily possible. In order to evaluate the elongation of the conductive layer after shaping, the sample was created using the above-mentioned exfoliating method. In the part which elongation after fracture is 1.5% and received 50% of processing in the part which received 5% of processing, elongation after fracture was falling to 0.8%. When heat-treatment of 2 hours was performed by 400 degreeC for elongation and shock-proof recovery, the elongation after fracture of the conductive layer was about 3% of value by softening by any part. When the aforementioned impact resistance test was carried out to the lateral portion of a cast, the crack of that by which the crater was observed was not observed.

[0046][Example 3] As the aluminum 8 of drawing 3, the circle plate of construction material JIS3004 system aluminum containing alloy MG-110 (product made from the Sumitomo light metal) (0.6 to 0.8% of Mg and 0.9 to 1.1% of Mn are included), size the thickness of 1.5 mm, and 425 mmphi was used. That with which the fluoro-resin 7 is covered was used for one side of a circle plate. This substrate was immersed in the 70 ** solution of 80 g/L of SZ etching agents made from KIZAI, Inc. for 60 seconds, and dissolution removal of the natural oxidation film on the surface of an aluminum containing alloy was carried out. Then, it was immersed in the room temperature solution of 700 ml/L of nitric acid for 30 seconds 68%, and the firm oxide which remains on the surface was dissolved. Next, it was immersed in the solution of product made from KIZAI, Inc. super zincate SZ2 for 60 seconds at the room temperature, and the substitution deposit of the zinc alloy 9 was carried out on the aluminum base material. Then, the substrate and the shield which has a breakthrough 120 mm in diameter between the anodes have been arranged in an electrolytic bath, electroplating was given to the center-section subject, and the conductive layer 10 of the letter of upheaval was generated.

[0047]At this time, the used electroplating liquid 480 g/L of nickel amiosulfonate 4 hydrates, 25 g/L of ferrous sulfate 7 hydrates, 30 g/L of way acid, 20 g/L of sodium gluconate, 1 g/L of saccharin sodium, 0.1 g/L of sodium lauryl sulfate, Sulfamic acid NH_2SO_3H15 g/L was used, it processed under the nitrogen gas bubble for 100-ml/by 45 ** of bath temperature, and cathode-current-density 25 A/dm^2, and about 150-micrometer nickel-20%Fe coat (permalloy) 10 which is a conductive layer was formed in the aluminum alloy sheet side. 680 g/L of nickel amiosulfonate 4 hydrates after carrying out surface washing of this substrate with chloride 10%, It processed by cathode-current-density 20 A/dm^2 in the 50 ** solution of 20 g/L of nickel chloride 6 hydrates, and 40 g/L of way acid, and about 10 micrometers of nickel plating 11 were formed on the surface of the ferronickel alloy film 10. When the specimen was prepared by the same method as Example 2 in order to investigate the elongation after fracture of only a conductive layer, and the elongation after fracture of this specimen was investigated, 7% of elongation after fracture was shown.

[0048]It has been divided and processed, when processing was tried in a depth of 146 mm, and rice cooking jar inner kettle shape 221 mm in inside diameter so that a conductive layer might become outside with a hydraulic press, as shown [covering plate / this] in drawing 4. In this molding process, a maximum of 50% of elongation was checked by the flank part. In the rising portion from a bottom portion to a flank part, it was 5% of elongation. When cooking rice was carried out using the jar rice cooker of marketing of a cast, it checked that cooking rice was satisfactorily possible. When the specimen was prepared and the elongation after fracture of only the conductive layer of this container was measured by the same method as Example 2, the standup portion from the bottom portion which the elongation after fracture of 2% and 5% of elongation generated in the lateral portion which 50% of elongation generated to a flank part showed 6.5% of elongation after fracture. When elongation after fracture carried out the aforementioned impact resistance test to the lateral portion which became small most, the crack of what produced the crater was not observed.

[0049][Example 4] The cast with a thickness of 1.5 mm made into the shape of an iron pot where construction material JIS3004 system aluminum alloy MG-110 (product made from the Sumitomo light metal) (0.6 to 0.8% of Mg and 0.9 to 1.1% of Mn are included) is shown in drawing 5 was used as a substrate. The sizes of the cast of this aluminum alloy 13 are 146 mm in depth, and 221 mm in inside diameter, and the fluoro-resin 12 was covered to the inner surface of the iron pot. This cast was immersed in the 70 ** solution of 80 g/L of SZ etching agents for 60 seconds, and dissolution removal of the oxidation natural film of an aluminum cast was carried out. Then, it was immersed in the room temperature solution of 700 ml/L of nitric acid 68% for 30 minutes, and the firm oxide which remains on the surface was dissolved. Next, it was immersed in the room temperature solution of product Spa zincate SZmade from KIZAI, Inc.2, and the substitution deposit of the zinc alloy 14 was carried out on the outside surface of an aluminum cast.

[0050]Use these mold goods as a substrate and as a Fe-nickel plating bath 480 g/L of nickel amiosulfonate 4 hydrates, 25 g/L of ferrous sulfate 7 hydrates, 30 g/L of boric acid, hydroxylamine hydrochloride NH2 OH-HCl15 g/L, 1 g/L of saccharin sodium, 0.1 g/L of sodium lauryl sulfate, Sulfamic acid NH2SO3H15 g/L was used, it processed under nitrogen gas bubbling for 100-ml/by bath temperature 45degreeC and cathode-current-density 25 A/dm^2, and about 150-micrometer nickel-Fe20% coat 15 which is a conductive layer was formed in the aluminum alloy plate rear face. Aiming at corrosion-resistant improvement, 40 g/L of chromic anhydrides and 45 g/L of sulfuric acid solution were used as the electrolysis solution, and plating processing was performed for 10 minutes with the current density of 5 A/dm^2. Then, about 1 micron of a chromium metal and chrome oxide composite layers 16 were formed.
[0051]When cooking rice was carried out using the jar rice cooker of marketing of the container which processed to the cast, it checked that cooking rice was satisfactorily possible. When corrosion-resistant evaluation was furthermore performed based on the neutral salt spray test method of container JISZ2371, the solution of a chromic anhydride and sulfuric acid did not perform plating processing, but discoloration was checked a little brown by processing of about 50 hours in the sample which the conductive layer exposed, but. In the sample created according to this example, discoloration was not checked even processing of 1000 hours.
[0052]The sample in which the adhesion of the conductive layer was reduced was prepared in order to investigate the elongation after fracture of only a conductive layer. Mold goods were immersed in the 70 ** solution of 80 g/L of SZ etching agents made from KIZAI, Inc. for 60 seconds, and dissolution removal of the oxidation natural film on the surface of an aluminum alloy was carried out. Then, it was immersed in the room temperature solution of 700 ml/L of nitric acid for 30 seconds 68%, and the firm oxide which remains on the surface was dissolved like ****. Next, generation of a zinc alloy coat is not performed for the purpose of falling the adhesion of the plating coat on an aluminum surface, 480 g/L of nickel amiosulfonate 4 hydrates, 25 g/L of ferrous sulfate 7 hydrates, 30 g/L of boric acid, hydroxylamine hydrochloride NH2 OH-HCl15 g/L, 1 g/L of saccharin sodium, 0.1 g/L of sodium lauryl sulfate, Sulfamic acid NH2SO3H15 g/L was used, it processed under nitrogen gas bubbling for 100-ml/by bath temperature 45degreeC and cathode-current-density 25 A/dm^2, and about 150-micrometer nickel-Fe20% coat 15 which is a conductive layer was formed in the outside surface of a cast. Cut processing of the cast was carried out and only the conductive layer was torn off. The conductive layer removed from the kettle bottom side was prepared in the shape of the JIS No. 5 specimen, and it was considered as the specimen. When the elongation after fracture of this specimen was investigated, 7% of elongation after fracture was shown.
[0053][Example 5] Aluminium cast AC4C (it others-Cu(s) and 6.5 to 7.5% of Si) the case where Fe, Mn, Mg, and Zn are included as an impurity -- it is -- it used and, near an iron pot gripping section and as for a body center section, the thickness made into the shape of an iron pot as shown in drawing 7 used the 10-mm cast 18 as a substrate, as for 5 mm, the idiosoma lower

half, and the bottom portion. The sizes of this cast are 180 mm in depth, and 210 mm in inside diameter, and the fluoro-resin 17 was covered with baking finish after sandblast treatment to the inner surface of the iron pot. Covering of this fluoro-resin may be carried out to internal-and-external-surfaces coincidence after covering of a conductive layer.

[0054]Mold goods were immersed in the 70 ** solution of 80 g/L of SZ etching agents for 80 seconds, and dissolution removal of the oxidation natural film of an aluminium cast was carried out. Then, it was immersed in the room temperature solution of 700 ml/L of nitric acid for 30 seconds 68%, and the firm oxide which remains on the surface was dissolved like ****. Next, it was immersed in the room temperature solution of super zincate SZ2, and the substitution deposit of the zinc alloy 19 was carried out on the outside surface of an aluminum cast. After carrying out a substitution deposit for the improvement in adhesion, it was immersed in the room temperature solution of 700 ml/L of nitric acid for 20 seconds 68%, and zinc was dissolved selectively, it was further immersed in the room temperature solution of super zincate SZ2, and the substitution deposit of the zinc alloy was again carried out on the outside surface of an aluminum cast.

[0055]Use these mold goods as a substrate and as a Fe-nickel plating bath, 320 g/L of nickel sulfate 7 hydrates, 20 g/L of nickel chloride, 18 g/L of ferrous-sulfate 7 hydrates, The electrolytic bath which added 20 g/L of sodium ascorbate is used as a stabilizing agent of 30 g/L of boric acid, and divalent iron, It processed under nitrogen gas bubbling for 100-ml/by 60 ** of bath temperature, and cathode-current-density 25 A/dm^2, and about 150-micrometer nickel-Fe25% which is a conductive layer of iron nickel alloy coat 20 was formed in the aluminum alloy side. The sample which carried out the air bubble instead of the nitrogen gas bubble was also prepared for comparison. About the thickness of film, it set up by arranging arrangement of the anode of plating processing on an iron pot flank part or the side become plating with the thick Mabe bottom portion. 150 micrometers in thickness of the statement by this example were the thickness of the bottom-of-a-pan portion, and it was about 10 micrometers near the body part center. After performing blast processing for the outside surface of a conductive layer aiming at corrosion-resistant improvement, baking finish of the fluoro-resin 21 was carried out like the inner surface.

[0056]When cooking rice was carried out using the jar rice cooker of marketing of the container which processed to mold goods, it checked that cooking rice was satisfactorily possible. By the sample which created the container according to this example when corrosion-resistant evaluation was performed based on the neutral salt spray test method of JISZ2371, discoloration was not checked after the examination of 1000 hours. The elongation after fracture of only a conductive layer as well as Example 4 carried out cut processing of the cast, and tore off only the conductive layer. The conductive layer removed from the kettle bottom side was prepared in the shape of the JIS No. 5 specimen, and it was considered as the specimen. When the elongation after fracture of this specimen was investigated, 7% of elongation after fracture was shown.

[0057]The aforementioned impact resistance test was carried out to the bottom and the side, and as a result of observing the shocked part, defects, such as a crack, were not observed by the coat although the crater was observed as for all. Similarly, the aforementioned impact resistance test was carried out to the bottom and the side to the container by air bubbling. As a result, as a result of what is depended on an air gas bubble observing the shocked part, the crack clear to the circumference of a crater was checked and the tip of the crack had resulted even in aluminum. In the iron pot which produced this crack, when the heat generation characteristic was investigated using Matsushita Electric IH cooker KZP1, there were few rises of skin temperature and only the rise of about 20 ** was checked in 10 seconds.

[0058]

[Effect of the Invention]Even if the container for induction heaters of this invention molds the metal plate of the outside surface of aluminum or an aluminum alloy for which elongation after fracture forms 30% or less of conductive layer 1% or more in part at least into vessels, such as a rice cooking jar, by electroplating, It cannot fracture and an efficient exothermic layer can be formed.

[0059]Since a conductive layer is the metal or the alloy layer which serves as a heating element when the eddy current generated by the magnetic flux of high frequency flows, it can form an efficient exothermic layer. Since the thickness of a conductive layer is formed still more thickly than the depth of the skin effect which becomes settled with the frequency of an eddy current, and the material of said conductive layer, it can form an efficient exothermic layer.

[0060]Since the thickness of a conductive layer is beforehand formed before a molding process so that the thickness of said conductive layer after the molding process of a metal plate may become still thicker than the depth of the skin effect which becomes settled with the frequency of said eddy current, and the material of said conductive layer in the range in which the elongation of said conductive layer does not exceed elongation after fracture, Even if it molds into the jar for cooking rice, it is possible to form the original exothermic layer. Since the interlayer who consists of zinc or a zinc alloy is formed between the outside surface of aluminum or an aluminum alloy, and a conductive layer, it is possible to stick a conductive layer.

[0061]Since the conductive layer has performed electroplating according the monolayer which comprises at least one of nickel or a nickel alloy, iron or an iron alloy, cobalt, or the cobalt alloys, or two or more layers to non oxidizing gas bubbling, A crack cannot be produced in a conductive layer, it can be made cheap in comparison, and the conductive layer of suitable thickness can be formed suitably, and efficient generation of heat can be acquired. Since the conductive layer is made to distribute at least one element of Lynn, carbon, or boron further, the heating efficiency of a conductive layer can be raised to it.

[0062]Since the corrosion-resistant layer of a chromium layer is formed, it is not corroded by the outside of a conductive layer even if it continues for a long period of time. Since it has a

coat to which or more 0.2 the chromium metal and chromium oxidation thing of 1 micrometer or less of thickness have multilayer structure in a way outside a conductive layer and is not corroded, health is maintained over a long period of time. Since the outside surface of aluminum or an aluminum alloy is covered with the fluoro-resin, it is not corroded and health is maintained. Since it is molding into the container so that a conductive layer may become outside, molded products for electromagnetic heating, such as a rice cooking jar, can obtain comparatively easily.

[Translation done.]